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(54) Modular electronic printer architecture

(57) An electronic printing system comprises a substrate, controllably transported through the printing system past a plurality of print heads and print stations in sequence, to generate a printed image. The print heads are mounted on a swing arm mechanism to allow rotation from a print-ready position into a service position. The system is created from simplex print modules and is capable of multi-color and process color duplex printing without turnbars between print stations. The system is configured so that additional print stations can be added to the printing system without adding substantially to the length of the system.

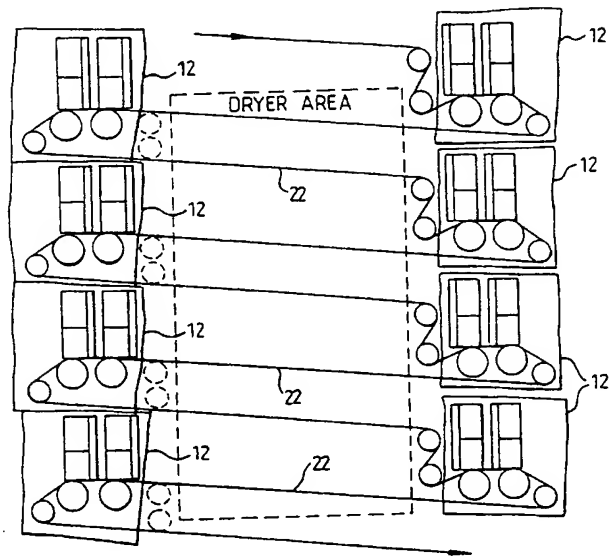

FIG.2

EP 0 813 971 A2

Printed by Jouve, 75001 PARIS (FR)

Description

This is a continuation-in-part of application Serial No. 08/543,944 filed on October 17, 1995.

Technical Field

The present invention relates to electronic printing systems and, more particularly, to the architecture of high speed web presses for electronic printing.

Background of the Invention

Electronic printing includes all ink jet printing, such as continuous ink jet printing, and all other systems wherein images are dried to fix the image on the substrate, as well as ionography, electrophotography, and all other systems wherein toner is fused to fix the image on the substrate. Current large scale electronic printing presses, typified by the Scitex 3500/3600 family, manufactured by Scitex Digital Printing, Inc., of Dayton, Ohio, are configured with a standard fuser/fixer or fixer/dryer system and are capable of drying at high speed, and full width.

The design of a typical fixer/dryer is very much related to the designs of fixers in general use in the printing industry. Typically, dryers are purchased as standard configurations, which are available with few options. They can be used at lower power if they are to be used at low speed, but standard products are generally not modular in the sense to be described below.

Conventional printing presses arrange all the apparatus for printing in a tower. Paper is fed to the tower by appropriate paper feeding apparatus using either sheets of paper, or a continuous web of paper. Typical color printing presses utilize multiple "towers". The paper is fed sequentially from one tower to the next, each tower printing a particular color (or sometimes a transparent coating). For printing processes which require fixing of one color ink before the next color ink is printed, a standard fixer/dryer is used between towers.

When it is desired to print on both sides of a substrate, there are several options in common usage. In one common web press configuration the first side is printed in a first tower and then a second tower is used for printing on the reverse side. In this type configuration, a turnbar is required between towers. A turnbar is an arrangement of rollers which have the effect of inverting the web so that the unprinted side of the paper is available for printing in a subsequent tower. Typically, at least four colors are needed on each side of the paper, so eight towers are required. Obviously, the result is a long printing press, especially if dryers are required between print impressions. Long printing presses have associated problems which include excessive floor space requirements and, for digital printing systems, excessive data memory requirements.

Another common web configuration is called a "perfecting" press. In this configuration, print stations are positioned on each side of the web, so that both sides of the substrate are printed essentially simultaneously. This helps the floor space requirements, but the press setup is complicated by the dense packing of the equipment.

Furthermore, when printing at high speeds with ink jet presses, a roller is needed on the unprinted side of the substrate to hold the web flat and close to the print head, and the "wet" side of the substrate cannot be contacted immediately after printing. Therefore, a perfecting press design is not possible.

It is seen, then that there is a need for an improved electronic printing architecture which overcomes the problems associated with prior art electronic printing system architectures, and, in particular, does not add substantially to the length of the printing system.

Summary of the Invention

This need is met by the present invention which discloses a modular ink jet printer architecture wherein printers are allowed to be constructed from modules which can be upgraded for increased number of colors, increased capability in speed, simplex/duplex and print width, and which enables compact, cost effective systems.

In accordance with one aspect of the present invention, an electronic printing system includes substrate supply means, and means for controllably transporting the substrate through the printing system past a plurality of print stations in sequence. Each of the print stations are capable of printing on one side of the substrate. The system further comprises means for fixing the printed image between image stations without contacting the printed side until it is dry, and means for collecting the completed print work by rewinding the work on a roll, cutting the work into pages and stacking it, or any other suitable finishing operations. Print heads are mounted on a swing arm mechanism to allow rotation from a print-ready position into a service position. The system is created from simplex print modules and is capable of multi-color duplex printing without turnbars between print stations or print modules. The system is configured so that additional print stations can be added to the printing system without adding substantially to the length of the system.

It is an object of the present invention to improve the architecture of an electronic printer so that modular solutions to various printing problems can be obtained. It is another object of the present invention to provide a duplex color printing system which does not grow in length as more printing colors are required. It is a further object of the present invention to provide a modular system which can be field upgraded from one color to multiple colors, and from simplex to duplex printing without adding proportional length to the printing system. It is yet another object of the invention to enable a modular

upgrade path from page wide printing to two-up printing. It is still another object of this invention to provide an architecture in which the fixer/dryer is in a position separated from, and specifically not under, the electronic printing system. This has the advantage of insuring that the electronic print system is not affected by heat from the fixer/dryer. It is a further object of this invention to enable modular growth in drying capability as process speed increases. The present invention, therefore, provides the advantage of consolidating the dryers into a single modular unit to lower cost and enable improved management of the heat. The present invention provides the further advantage of enabling use of a single exhaust for air flow and a single insulated cabinet.

Other objects and advantages of the invention will be apparent from the following description and the appended claims.

Brief Description of the Drawings

Fig. 1 illustrates a paper path for the proposed printer architecture:

Fig. 2 is a side view of one embodiment of an electronic print station having eight print modules:

Fig. 3 illustrates an electronic print station wherein two print modules print on opposite sides of a substrate:

Fig. 4 illustrates a top view of the full width print head mounting system for one station: and

Fig. 5 illustrates a top view of the swing arm embodiment of the present invention wherein the entire print system is allowed to rotate by at least 90°.

Detailed Description of the Invention

The present invention is described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that modifications and variations can be effected without departing from the spirit and scope of the invention.

Referring to the drawings, a paper path for a proposed printer architecture 10 is illustrated in Fig. 1. The paper input and output features applicable to this invention are readily available standard components. The available options for paper input and output are quite broad. For exemplary purposes, the illustration depicts a system which uses a roll feed input and a sheeter/stacker output 11. Paper proceeds generally from the left to the right in the press illustrated. Paper from the roll proceeds through the region where duplex printing and drying are accomplished. The details of the print head fixer/dryer region vary, depending on the desired capability of the particular press.

In general, a print engine comprises two towers 14, 16 of print modules 12 with a fixer/dryer region 20 situated between the towers 14 and 16. A print module 12 typically comprises adjustable print head mounts, rollers, and cue sensors. In accordance with the present invention, print heads 18 are accessible to the system operator. The print head mounts in the print module 12 could be rotated 90° about a vertical axis pivot on one side of the module 12, to provide the system operator print head access. The arrangement according to the present invention enables multi-color duplex printing in a very compact architecture, without requiring turnbars between print stations.

After a substrate 22 from web feed 24 emerges from the printing and drying area, it moves into a finishing region 26. As known by those skilled in the art, finishing comprises various tasks, including but not limited to collecting the completed print work by rewinding it on a roll, cutting it into sheets or pages. stacking, folding, collating, etc.

Referring now to Fig. 2, there is illustrated a side view of an embodiment of an electronic print station having eight print modules 12. Although the print engine of Fig. 2 is comprised of eight print modules 12, it will be obvious to those skilled in the art that the number and arrangement of print modules may vary without departing from the scope of the present invention. Of course, as will be understood by persons skilled in the art, the right hand stack of print modules is not needed if only one side of the substrate is being printed.

In a preferred embodiment of the present invention, the print stations comprise ink jet print stations in an ink jet system. The ink jet system may comprise a continuous ink jet system or a drop-on-demand ink jet system. The system could further comprise a continuous binary ink jet system having either a variable or a fixed number of drops per spot printed. The number of pixels per inch is preferably at least eighty. The maximum number of drops printed per spot is typically between one and sixty-four. In a further preferred embodiment, the ink jet system comprises a duplex full process color printing system. Although the process speed is typically at least fifty feet per minute, the speed could be slower, such as for a drop-on-demand system.

Fig. 3 is an illustration of two print modules 12 printing on opposite sides of substrate 22. The substrate 22 enters from the top left of Fig. 3, as indicated by arrow 30, and is wrapped around rollers 32 which provide a positive wrap around roller 34. The positive wrap provides a fixed position for printing. In the configuration shown in Fig. 3, there are four print heads 18. For the purposes of this illustration, but not to be considered as limiting the invention, it is assumed that an eighteen inch print swath is to be created with the use of two nine inch print heads. This approach provides modularity in width. If the required print width is only, for example, nine inches, only one print head is required at each print station. The print head over roller 34 is spatially closer to the viewer than the print head over roller 36, which is further from the viewer. Print heads which are physically wider than their print swaths are staggered so that their print swaths butt (stitch), allowing the desired eighteen inch total print swath.

Again, for illustration purposes only, it is assumed that the print heads 18 print down. Roller 38 touches the opposite side of the web from the unfixed image. As the web proceeds through the fixing region 40, the bottom, or print side, of the web is heated, and the image in fixed. The web now proceeds to rollers 42 and 44, where an image is placed on the opposite side of the web from the image placed at the earlier print stations at rollers 34 and 36. The result is a duplex image created without a turnbar. The web now passes through the dryer area 20 again, and the unfixed image on the bottom of the web is fixed.

Several features of the approach of the present invention are apparent from Fig. 3. First, there is right side module 12 comprising two print heads 18 over rollers 34 and 36. The right side module 12 is identical to or the mirror image of left side module 12, comprising two print heads 18 over rollers 42 and 44. Also apparent from Fig. 3 is that the dryers 40 are the same as dryers 50. The dryers 40 and 50 are themselves modular. The means for drying is positioned so that heat from the dryer does not affect print mechanisms. In the configuration illustrated, there are two dryers. However, if there are two product embodiments, one of which is rated at, for example, 300 feet per minute, and the other of which is rated at a throughput of 600 feet per minute, the lower throughput device could use one module in its dryer, while the higher throughput device could use two modules, side by side. Further, the dryers could be modular in width, so that, for example, a nine inch print width could use a single dryer, while the comparable eighteen inch print width would use two dryer modules, each drying half the print width.

Another level of modularity comprises the entire single color print system illustrated in Fig. 3. This system occurs at four positions in Fig. 2, to make up a four color duplex printer. In that context, it should be observed in Fig. 3 that the web enters the dryer area at the top left at the same angle as the web exits at the lower right. Of course, those skilled in the art will recognize that there are many variations of print options achieved by combining print modules, such as printing two colors on a front side of the substrate and one color on a back side, or three colors on a front side and two on a back side, or one color on a front side and three colors on a back side, etc.

A further feature of the print system illustrated in Fig. 3 is that opposite pairs of print heads 18 are at the same vertical height. This enables simpler maintenance and also allows for a stackable module. If a fifth print station is required for a particular system, it can be added to the system in a straightforward manner, without lengthening the digital printer. It is also possible, with the present invention, to add a second tower to provide fifth and/or sixth color capability, although this, of course, would lengthen the system.

Referring now to Fig. 4, and continuing with Fig. 3, there is illustrated a top view of the mounting of the print heads 18, showing how multiple print heads, specifically two print heads, are used to cover the total printed width. In accordance with the present invention, print heads 18 are accessible to the system operator. The print head mounts in the print module 12 can be rotated by 90° about vertical axis pivot points 51 and 53 on one side of the module 12, to provide the system operator print head access. The print head which prints on the left side of the web is placed over roller 36, and is attached to swing arm 50. The right side of swing arm 50 is detachably fixed to a stop 55, typically located on the right side of the printing system. In the detached position, swing arm 50 assumes a position 50a at which the print head is serviceable by an operator. Similarly, swing arm 52 can swing about the pivot point 53 to assume the position 52a illustrated. This enables print head service by approaching the print head from the perspective 58.

Referring again to Fig. 4, 55 illustrates an exploded view of the attachment point of either swing arm 50 or 52. For exemplary purposes a knurled screw 60 is shown as the means of attachment, but it is clear to one skilled in the art, that other quick detachment means could be used. The attachment means attaches the bar 50 (or 52) to a stop 54 which is slidably attached to a member 56 which is fixed to the frame of the electronic printing system. Movement of the stop 54 relative to the fixed member 56 by suitable adjusting means (not shown) creates a small change in the angle of the swing arm 50 (or 52). This changes the angle of the print head 18 relative to the axis of the roller 36 (or 34) and allows perfect alignment of the axis of the print head to the printing mechanism axis. The system which mounts the print head 18 to the swing arm also allows significant adjustment in the "y" axis illustrated in Fig. 4 so that the print swaths of the print heads on rollers 34 and 36 can be perfectly aligned with one another. The mounting means also allows some degree of motion in the "x" direction, so that the print heads can be positioned properly with relation to the rollers 34 and 36. This latter adjustment is especially important because adjustment of the swing arm attachment point 54 also causes some motion of the print head in the "x" direction as a result of the alignment of the print head and roller axes.

In a preferred embodiment of the present invention, shown in Fig. 5, the entire print system, comprising module 12, fixer/dryer region 20, and tower 16, can optionally be rotated 90° by means of one turnbar at the top of unit 20 and one turnbar at the bottom of unit 20. Thus, the print modules 12 can face aisles on either side of the web flow, enabling viewing and print head access, as well as shortening the length of the overall system.

Industrial Applicability and Advantages

The present invention is useful in the field of electronic printing, and has the advantages of improving the architecture of an electronic printer so that modular solutions to various printing problems can be obtained. It

is another advantage of the present invention that it provides a duplex color printing system which does not grow in length as more printing colors are required. It is a further advantage of the present invention that the modular system can be field upgraded from one color to multiple colors, and from simplex to duplex printing without adding proportional length to the printing system. It is a further advantage of the invention that it enables a modular upgrade path from page wide printing to two-up printing. It is another advantage of this invention that it provides an architecture which positions the fixer/dryers such that they are consolidated in a single cabinet and separated from, and specifically not under, the electronic printing system. This has the advantage of insuring that the electronic print system is not affected by heat from the fixer/dryer. It is another advantage of this invention that print head mounting on a swing arm allows accurate alignment of the printing axis and the paper motion, and additionally allows easily accessible print head servicing. It is yet another advantage of this invention that it enables modular growth in drying capability as process speed increases.

The invention has been described in detail with particular reference to certain preferred embodiments thereof. but it will be understood that modifications and variations can be effected within the spirit and scope of the invention.

Claims

1. An electronic printing system comprising:

   at least one print head
   a swing arm mechanism to which the at least one print head is mountable, the swing arm mechanism allowing rotation of the at least one print head from a print-ready position into a service position;
   substrate supply means for supplying a substrate: and
   means for controllably transporting the substrate through the electronic printing system past the at least one print head to generate a printed image.

2. An electronic printing system as claimed in claim 1 wherein configuration of the system enables the at least one print head to be placed in an approximately vertical alignment over the substrate.

3. An electronic printing system as claimed in claim 1 further comprising a frame for defining structural rigidity of the electronic printing system.

4. An electronic printing system as claimed in claim 3 further comprising a mounting means for mounting the swing arm to the frame of the printing system.

5. An electronic printing system as claimed in claim 4 wherein the mounting means comprises an easily detachable mounting means.

6. An electronic printing system as claimed in claim 5 further comprising slidable attachment means for slidably attaching the mounting means to the frame, whereby the print head axis can be aligned to the printing system axis, utilizing the swing arm as a rotation means.

7. An electronic printing system as claimed in claim 3 further comprising attachment means for attaching the at least one print head to the swing arm mechanism.

8. An electronic printing system as claimed in claim 7 wherein the attachment means allows adjustment of the at least one print head in an "x" direction and in a "y" direction.

9. An electronic printing system as claimed in claim 1 wherein the electronic printing system comprises a continuous ink jet system.

10. An electronic printing system as claimed in claim 1 wherein the electronic printing system comprises a duplex full process color printing system.

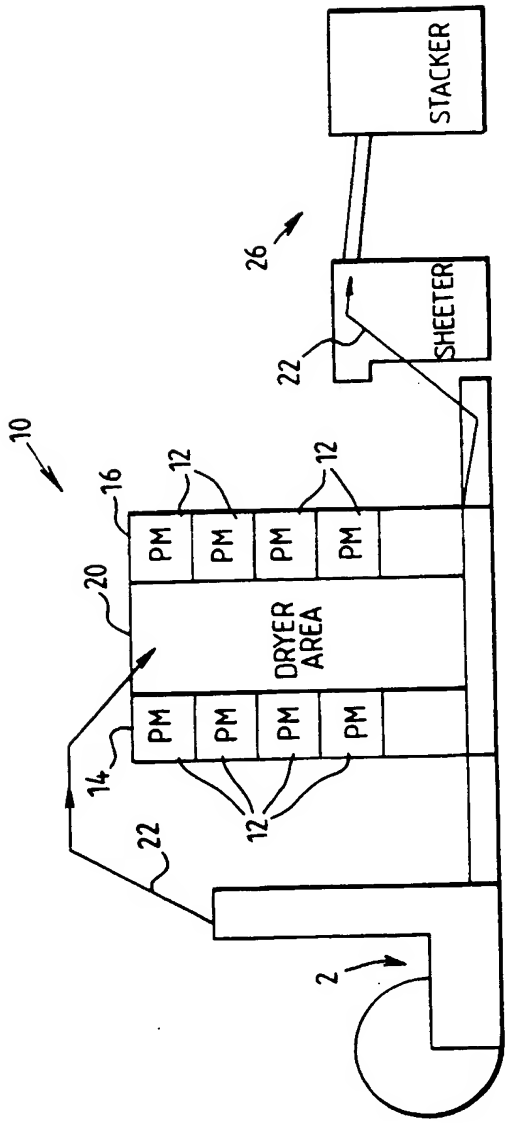
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FIG.1

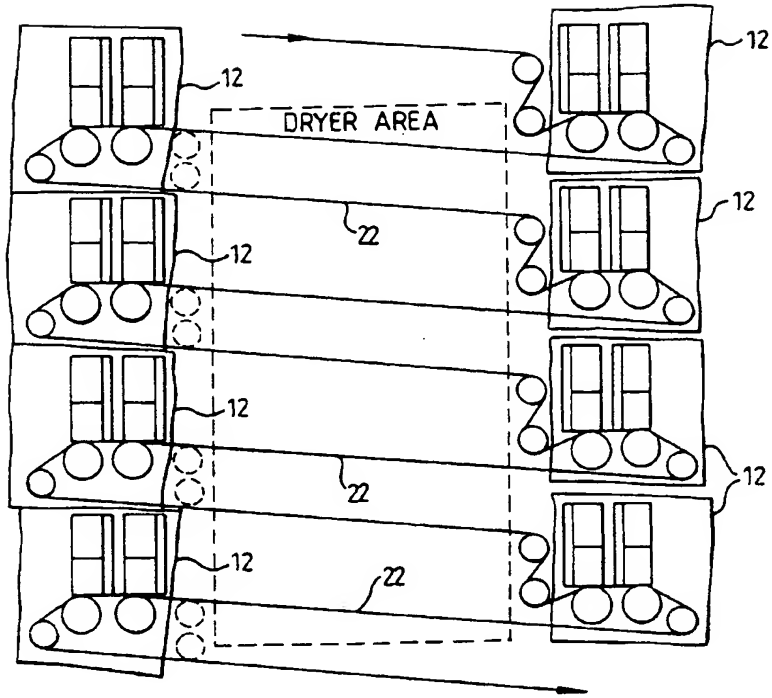


FIG.2

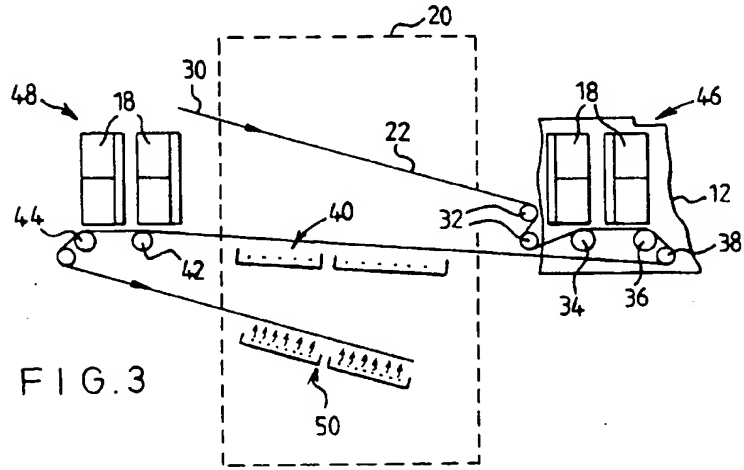
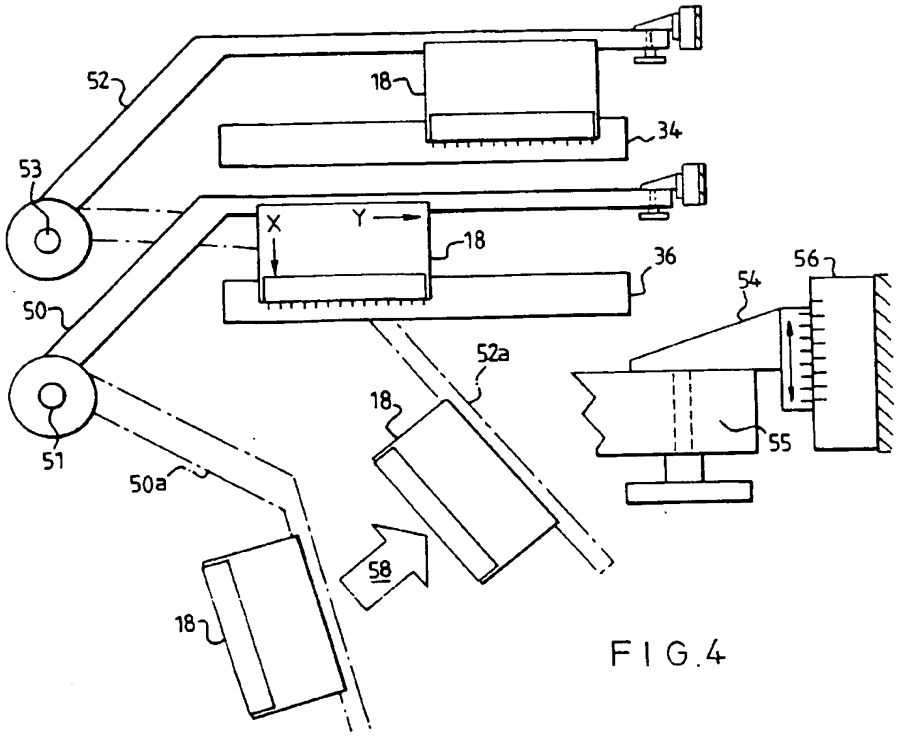


FIG.3


52
18
34
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Y
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36
56
54
50
52a
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55
51
50a
58
18

FIG.4

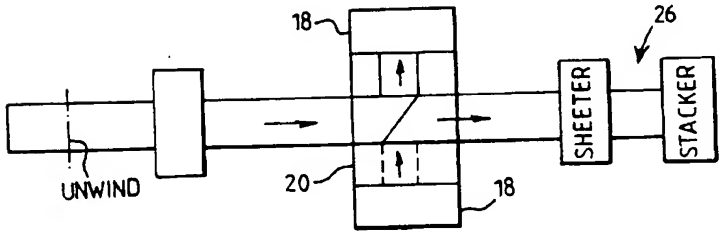
18
26
SHEETER
STACKER
UNWIND
20
18

FIG.5

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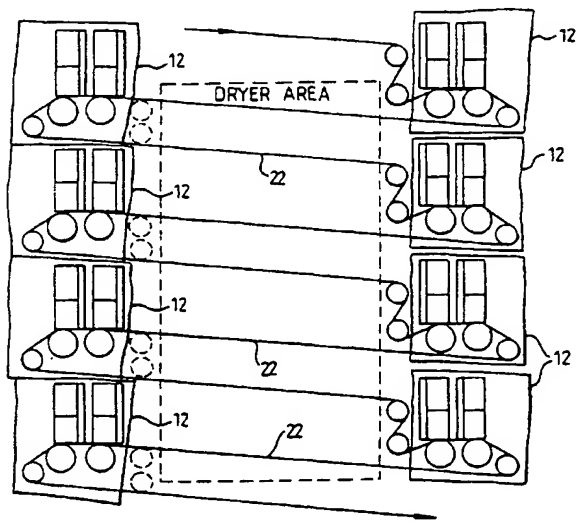

FIG.2

EP 0 813 971 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 30 4186

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y	PATENT ABSTRACTS OF JAPAN vol. 012, no. 257 (M-719), 20 July 1988 & JP 63 041159 A (FUJI XEROX CO LTD), 22 February 1988 * abstract *	1-7 9,10	B41J3/54 B41J3/60 B41J29/02 B41J25/316
X	PATENT ABSTRACTS OF JAPAN vol. 013, no. 545 (M-902), 6 December 1989 & JP 01 226375 A (SEIKO EPSON CORP), 11 September 1989 * abstract *	1-7	
Y	EP 0 711 063 A (NUR ADVANCED TECH LTD) 8 May 1996 * abstract * * column 5, line 14 - line 22 * * figure 1 *	9,10	
X	GB 2 159 770 A (CONTROL SYSTEMS LTD) 11 December 1985 * the whole document *	1-3	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
X A	DE 42 19 798 A (ESSELTE METO INT GMBH) 23 December 1993 * the whole document *	1-3 4-8	B41J
A	DE 36 16 925 A (ROBOTRON VEB K) 9 April 1987 * the whole document *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 010, no. 059 (M-459), 8 March 1986 & JP 60 206690 A (MATSUSHITA DENKI SANGYO KK), 18 October 1985 * abstract *	8	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10 November 1998	Didenot, B

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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